Environmental Measures and Exposures – an Overview

Jim Quackenboss, US EPA/ORD, NCS Program Office
Rod Larson, University of Utah Vanguard Site

US Department of Health and Human Services

NIH, CDC, NCHS, OS

US Environmental Protection Agency

THE NATIONAL CHILDREN'S STUDY

Overview of Presentation

- Process for Developing Exposure Assessment Approach
  - Hypotheses -> Agents
  - Approach and "Proposed" Measures

- Integrating Coordinating Center and Vanguard Center input

- Measurement Error Adjustment approaches

- Alternative Measurement Methods

"Technology-Environmental Measures Group"

- Composed of Program Office staff and other Feds, with limited contractor support

- Started in January, 2005 to:
  - Identify what the NCS needs to support testing of Study hypotheses (i.e., not a "survey")
  - Provide a <u>starting point</u> for environmental measurements (what, when, and how)
  - Identify rationale, suggested methods, and alternatives considered

Technology-Environmental Measures Group Evaluation Process
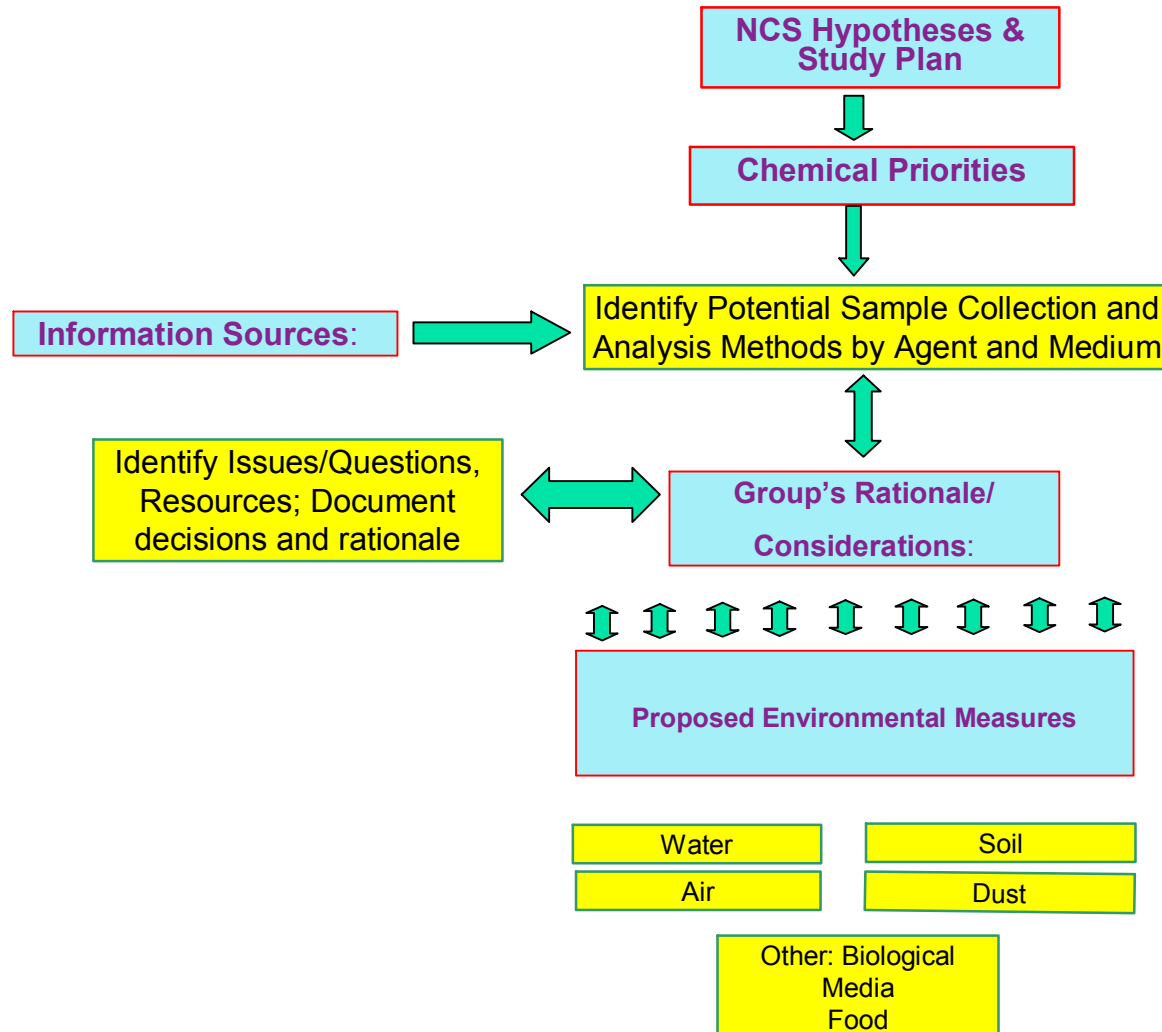
Key NCS Hypotheses for Environmental Measurements

- Non-Persistent Pesticides and Poor Neurobehavioral and Cognitive Skills

- Environmental Exposures and Genetic Variation Interactions and Asthma

- Indoor, Outdoor Air Pollution and Asthma Risk

- Disparities in Asthma and Physical Environment Risk Factors, Psychosocial Stress, and Health-Related Behaviors

- Chemical Environmental Agents and the Endocrine System and Age at Puberty

- Genetics, Environmental Exposures, and Type I Diabetes

- Early Exposure to Bacterial and Microbial Products Decreases Risk of Asthma

- Maternal Subclinical Hypothyroidism

See NCS Website for more information on specific research hypotheses

Exposure Domains

- Biological Agents

- Chemical Agents

- Physical Agents

- Physical Environment

- Psychosocial

(From NCS Study Plan)

Chemical

- Persistent Organic Compounds
- Non-persistent Nonvolatile Organic Compounds
- Non-persistent Semi-volatile Organic Compounds
- Non-persistent Volatile Organic Compounds
- Bioaccumulative Inorganic Chemicals
- Non-bioaccumulative Inorganic Chemicals
- Criteria Air Pollutants

Biological

- Bioallergens

Physical

- Radon
- Noise

Identifying Priority Chemical Analytes

- The NCS hypotheses were used to support the potential inclusion of chemicals/agents

- Classes of chemicals/agents were assessed for potential measurement in environmental and biological sampling media

- Identified a minimum set of target analytes (assumes that others may be available from same analysis run)

Hypotheses -> Example Target Analytes

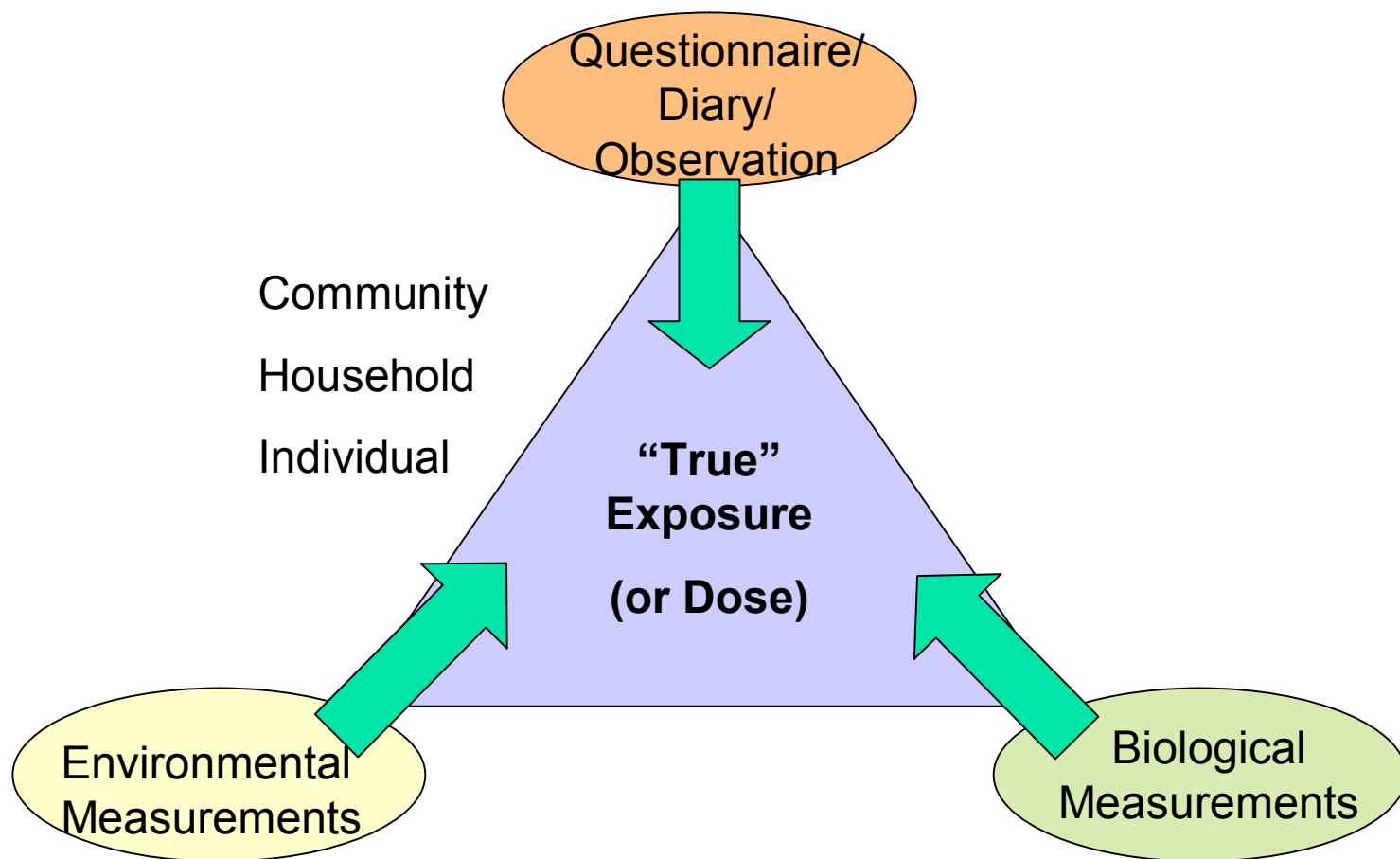| Analyte Class	Target Analytes	Related Outcomes
Allergens	cat, dog, cockroach, dust mite, fungi, mouse/rat urine, endotoxins	Asthma
Aldehydes & ketones	Formaldehyde, Acrolein	Asthma
Phenols	Bisphenol A, nonylphenol	Puberty
Bacterial and microbial products	Endotoxin (gram negative bacteria)	
Environ. Tobocco Smoke	nicotine	Asthma
	cotinine	Asthma
Metals	Pb	Puberty
	Hg (methyl, ethyl)	Neurodevel, Asthma, Puberty
	Hg (inorganic)	Thyroid
	Cd in PM 2.5	
	As	Neurodevel
PM2.5	PM mass	Asthma
Oxidants	Ozone, NO2	Asthma
Perchlorate	Perchlorate	thyroid
PAHs	PM	Asthma
PCBs	PCBs	Puberty, Neurodevel, Thyroid
dioxins/furans	dioxins/furans	Puberty, Neurodevel, Thyroid
halogenated phenols	PCP, PBP	Thyroid
phthalates	target phthalates	Puberty
Pesticides	OP's, Carbamates, Pyrethroids, EBDC/ETU	Neurodevel, Thyroid
	Atrazine	Puberty
	DDT, DDE, other OCs	Thyroid
Phytoestrogens		Puberty
VOCs	Benzene	Asthma
	Chloroform	Neruobehav
PBDE's	PBDE's	Thyroid, Puberty
PFOA/PFOS	PFOA/PFOS	Thyroid
PFBS	PFBS	?

Information Used in Identifying Exposure Measures

- NCS Hypotheses

- NCS Study Plan (Aims, Domains, Visit Schedule)

- The Exposure to Chemical Agents Working Group's (ECAWG) White Paper, other pilot studies, and EHP papers

- Federal scientists consulted for advice on specific methods and approaches

- Approaches used in other major field studies and "standard methods" (where available)

General Approach for Exposure Assessment in the NCS

Questionnaire/ Diary/ Observation

Community

Household

Individual

"True" Exposure (or Dose)

Environmental Measurements

Biological Measurements

Considerations/Rationale for Selection of Measures

- Hypothesis-based selection of agents

- Analytical methods which provide additional analytes

- Maturity of technology

- Environmental and Biological measurements
  - Rely on environmental when no suitable biomarker exists
  - Rely on biological for persistent chemicals and chronic exposures
    - Limited sample availability (parent chemical in blood)
  - Also consider environmental measures for non-persistent chemicals and intermittent exposures
    - Concern about specificity and interpretation of metabolite measurements

Rationale/Considerations (continued)

- National Scope of the National Children's Study

- Link measurements at different geographic scales
  - regional > community > home/work/etc. > individual

- Adequate method sensitivity

- Adopting approaches from similar studies or using established methods

- Consider sampling and analytical cost, and participant burden

- Sample storage stability and potential for future evaluation as technology evolves

Example Environmental Measures

Simplified Summary of Measures by Visit - Environmental Measurements

	Pre-Pregnancy				Pregnancy (clinic visits)			Post-natal			
	P1	P2	P3	P4	T1	T2	T3	1-Mo	6-Mo	12 mo	18-mo
Indoor Air											
PM10 & Pesticides	■	■	■	■	■	■			■	■	■
PM2.5	■	■	■		■	■			■	■	■
VOCs, aldehydes	■	■	■		■	■	■		■	■	■
Gaseous Air Pollutants	■	■	■		■	■			■	■	■
Radon					■						
House Dust											
Pesticides	■	■	■	■				■	■	■	■
Lead	■		■	■			■		■	■	■
Allergens, Mold, Pollen	■	■		■			?	■	■	■	■
Drinking Water											
Disinfection Byproducts (DBPs)	■		■	■					■	■	■
Metals	■		■						■	■	■
Nitrate (private wells)	■		■						■		■
Perchlorate (Community Level)	■		■						■		■
Soil											
Bldg perimeter - Metals		■			■				■	■	■
Mid-yard - Metal, pesticide (rural)		■			■						
Others											
Visual Assessment	■				■				■		■
Noise Survey					■				■		■
Moisture Survey					■			■	■		

- Dietary consumption
  - Mother: Combine
    - Two 24-hr recall Questionnaires [T2] with
    - Food Propensity/Frequency Questionnaires and Checklists [Pre-, Pregnancy, 1-mo (lactating)]
  - Child:
    - Feeding practices   [1, 6, 12-mo]
    - 3-day food checklist   [6, 12, 18-mo]
    - Food Freq. Quest.   [18-mo]
- Indirect ingestion (toddlers) [12-mo]
  - "migratory" eating behaviors
  - Mouthing behaviors

- Combine dietary consumption with contaminant databases (via coding and models) to estimate exposure to pesticides & metals

- Community food collection [T1, 18-mo]
  - Selected foods:
    - prepared in homes
    - composite by food type
    - link to consumption diaries for exposure estimates

Integration with Input from Coordinating Center & Vanguard Centers

"NCS Environmental-Team"

THE NATIONAL CHILDREN'S STUDY

NCS Environmental Team Membership

- Susan Viet, NCS Coordinating Center (Westat)
- Jim Quackenboss (EPA)
- Warren Galke (NICHD)
- Sarah Knox (NICHD)
- Carole Kimmel (NICHD)
- Stephen Bedosky (LFR Levine Fricke)
- Peter Blood (Westat)
- Chris Williams (Westat)
- IT/IMS coordinators (BAH; Westat)

Vanguard Center Representatives:
- Steve Colome (CA: UCLA)
- Bruce Lanphear (SD/MN: CCHMC)
- Rod Larson (UT: University of Utah)
- Paul Lioy (NY: EOHSI)

- Environmental "Team" -- Coordinating and Vanguard Center, and Program Office members
- Development groups
    - Environmental Sample collection Group
        - finalize proposed exposures/methodology/visits
        - develop SOPs
    - Environmental Questionnaires/observations Group
        - develop questionnaire and observation instruments
    - Statistical Group
        - strategy for subsampling, target sampling
        - validation studies (measurement error adjustment)
        - ensure measures will support outcome

Environmental Team Coordination

- Provide Input to other Teams
  - Biospecimen Team support (Biomarkers)
    - interface between biomarkers and environmental sample collection
  - Measures Team support (Diet)
    - ensure diet instrument addresses environmental contaminants
  - IT Group
    - support development of IMS components for environmental sample collection
  - GIS Group (support)
    - strategy for use of GIS in subsampling and community measures
    - potential use of GIS in exposure assessments

- Obtained feedback on proposed measures from ALL Vanguard Centers

- Current Status:
  - Prioritized when to consider/address comments
    - by timing, relative to OMB (burden)
  - Assigned to development groups
    - bring proposal back to full E-Team
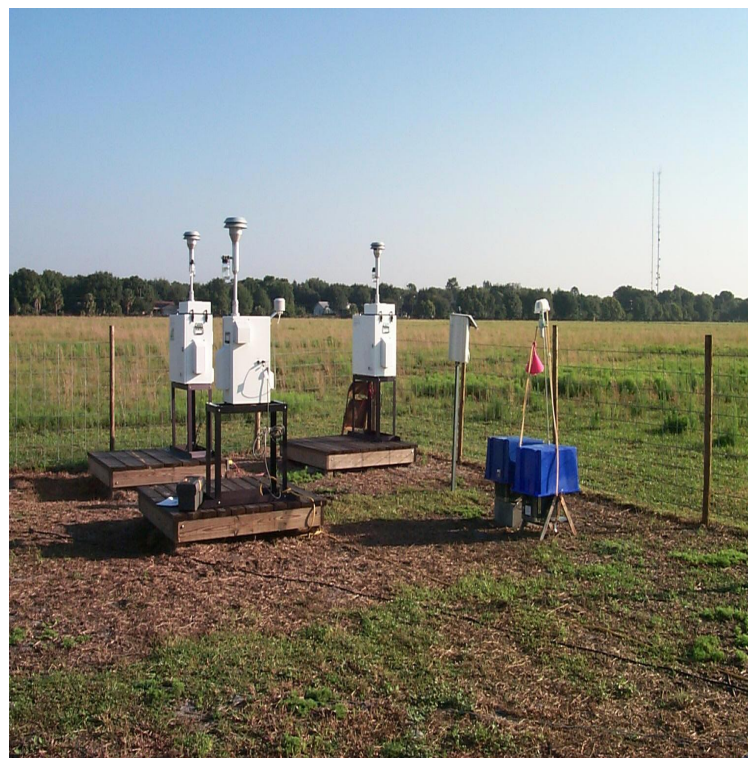 - Incorporated into overall protocol for environmental measures (for review)

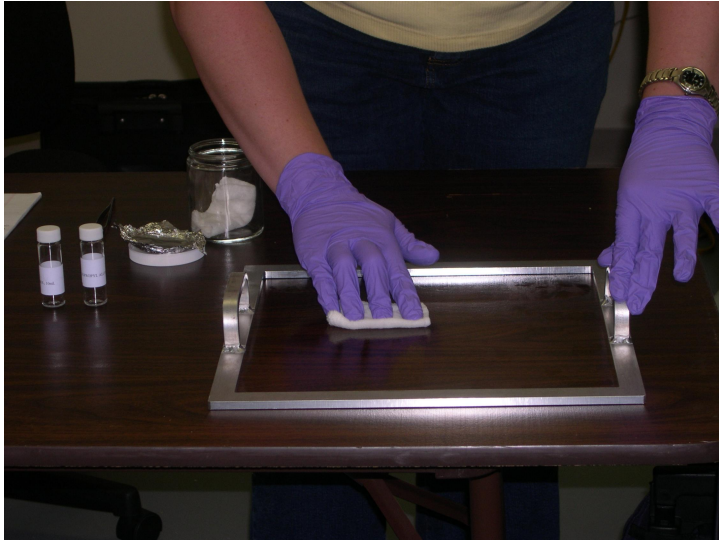# Examples of Environmental Measurement "Tools"

Activity time line

Accelerometer

Conclusions

- Challenge: to design an exposure assessment approach for a
    - Large scale, multi-purpose study
    - With >100K participants
- Overall Strategy:
    - Study hypotheses define information needs
    - Identify "core" measures
    - Relate measures taken at multiple geographic scales
    - Use Validation Samples to relate "true" exposure to "feasible" measures

Measurement Error Adjustment (Validation Studies)

THE NATIONAL
CHILDREN'S
STUDY

- NOT able to directly measure "total" exposures
  - Models often needed to estimate "true" exposure and dose from environmental and biomarker measurements
  - Limited to measurements at specified home visits
  - All measurements have sampling and analytical errors

- Support decisions relative to Study hypotheses:
  - Specifications for measurement and analytical methods (i.e., QA objectives/goals)
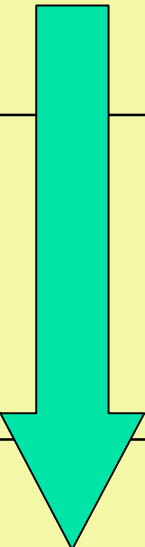 - Consider impact of alternative approaches, given resource & burden constraints

- Increasing "level of detail" often associated with increased costs and/or burden

- Options for selection of measurements
    - Method (sampling, analytical) specifications for accuracy, precision, detection limits, etc.
    - Frequency of measurements (relative to temporal variability) and number of sampling locations (e.g., within the home)
    - Selection of media (e.g., by life stage) and chemicals/agents relative to "true" exposure (and dose) and to priority outcomes
    - Scale of measurements (e.g., regional, community, household, individual)

Level of "Detail"	Air	Dust/Soil	Food/Diet
"Lower"	Ambient (Regional)	Dust Questions	National
	Community; HH In/Out Time-Loc'n	Dust + Diary	Community
"Higher"	Personal	Dust + Video + handwipe	Household/ Personal